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AUTOMATIC TARGET RECOGNITION (ATR)

TASK NO. 6: NPIC OPERATIONS

Prepared for

NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

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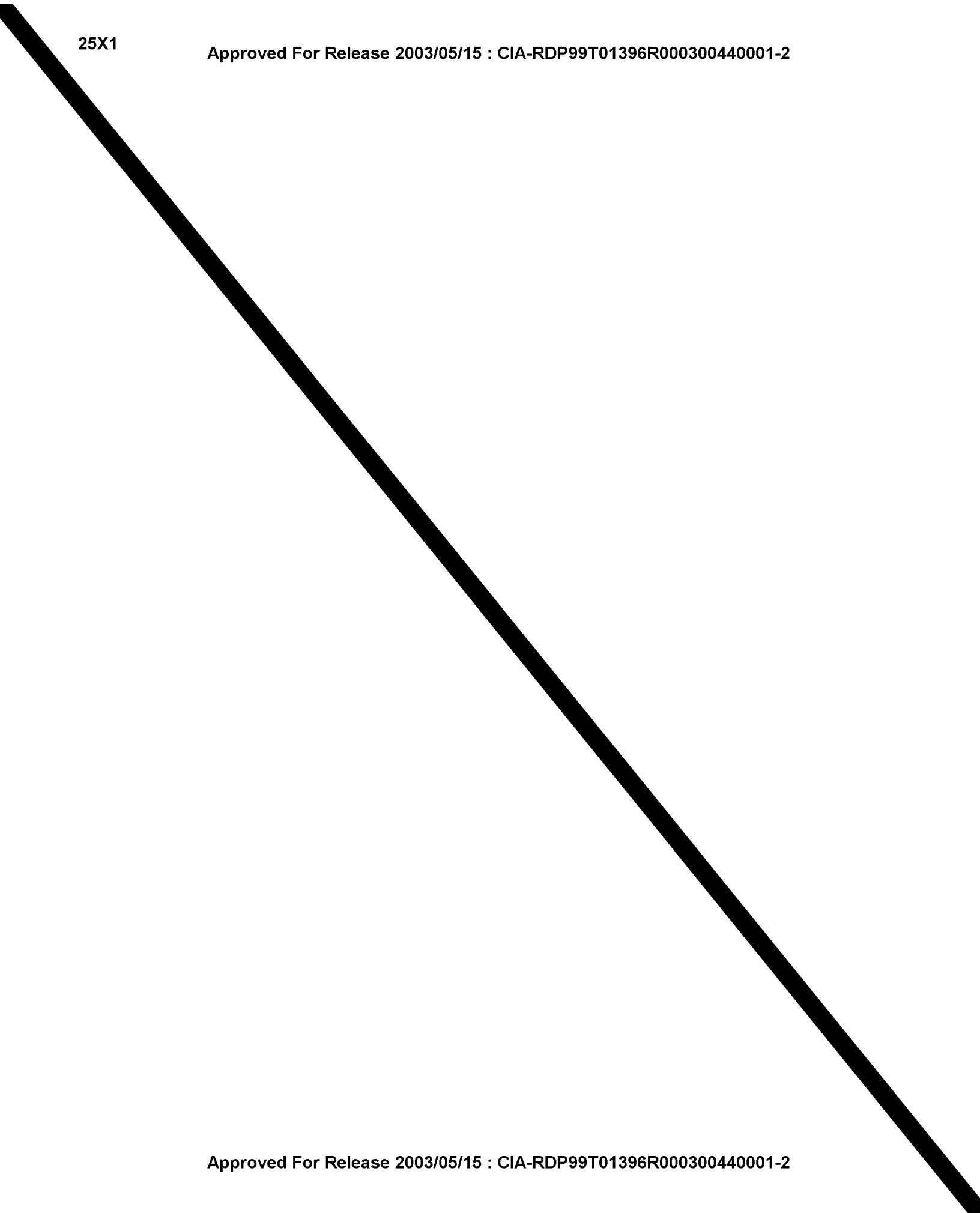

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TASK NO. 6

1. INTRODUCTION.

It was stated in the Automatic Target Recognition (ATR) Proposal, and reiterated in the Task #1 Report, that a detailed understanding of NPIC operations was essential to the success of an ATR Program. Of all programs sponsored by NPIC, probably none is as close to the heart of the photo interpretation operation as the ATR Program. It was a logical assumption, therefore, that knowledge of the NPIC environment in terms of targeting requirements, image characteristics, and interpreter handling procedures would refine task investigations and goals, and shape equipment design characteristics.

The investigation of the NPIC operation - Task #6 in Phase I of the ATR Program - has been slanted toward those user groups within NPIC who operate directly from the film record. Thus, support or service groups have been studied in less depth because of their individual roles in the photo interpretation process. The importance of supplementary information as an aid to target identification is not being overlooked in this investigation. It is realized that NPIC organizations responsible for photographic reproduction, computer processing, and report preparation and publication are essential to the operation of NPIC in meeting its assigned responsibilities. However, primary emphasis has been placed on those groups performing some aspect of photo interpretation because this function represents the basic purpose of the ATR Program.

The operation within NPIC has been the subject of extensive study by several commercial organizations, and the charters of the many NPIC divisions and groups have been published in considerable detail. Reference is made to the reports of the [redacted] 25X1A [redacted] entitled as follows:

25X1A

Integrated Information System (IIS)
NPIC Review and Function Flow (TOP SECRET)
3 June 1966, [redacted] SCR-273

1

Integrated Information System (IIS)
Conceptual Design and Functional Specifications (TOP SECRET)
19 August 1966, [redacted] SCR-288

1

Integrated Information System (IIS)
Program Implementation Plan (SECRET)
19 August 1966, SCR-289

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Supplement 1 [redacted] SCR-288 (TOP SECRET)
7 November 1966, [redacted] Supp. 1 SCR-288

Although certain projections as to the future workload of NPIC may be the subject of some contention, the general projection that the workload will increase considerably in the coming years cannot be disputed. This, in fact, is the major justification for the ATR Program.

The [redacted] program, and others which involve operations analyses, human factors, exploitation of unconventional imagery, etc., treat in some depth the operation of NPIC as applied to the general problem areas for which solutions are being sought. There will undoubtedly be overlap in these investigations; this is a necessary evil because of the specific needs of individual programs. The point to be made here is that no effort is being made in the Task #6 investigation to completely study and document the entire NPIC operation in depth. Only those operations directly pertinent to the area of automatic photo interpretation have been so treated.

The investigative approach followed in Task #6 was to have both [redacted] and NPIC (TDS) representatives present at all consultations with organizations or personnel at NPIC. This procedure offered both groups the opportunity to determine which interpretation operations appeared applicable to ATR implementation, and, moreover, to debate problems of conflicting opinions in order that final conclusions would represent a unified approach.

It should be understood that the intent of this ATR Program is not to replace P.I.'s with machines, but to provide some relief for the P.I. as soon as possible. Therefore, one approach in Task #6 was to attempt to isolate those duties performed by the P.I. which could be considered as repetitive, or non-interpretive in nature. Another avenue followed was to look for a consensus on the most time-consuming and least challenging aspects of interpretation at NPIC. From these and other approaches it was possible to eventually define interim goals for equipment development under the ATR Program.

The remainder of the Task #6 Report will describe how photographic imagery utilized at NPIC is processed, analyzed, and read-out in report form. The areas in which interpretation is conducted, and the relationship between those (and other) areas and automated machine analysis techniques, will be described as valid comparisons are developed.

2. THE NPIC ENVIRONMENT.

This section examines, in a general way, the NPIC operation from both the point of view of organization and that of function. The organizational structure is shown first, and pertinent facets of this structure are related to the film analysis cycle in a later section. This section is intended to provide background data which is described in more detail later in the report.

2.1. Organizational Structure

An organizational chart of NPIC is shown in FIG. 2-1. Although all major boxes within the chart are equal in administrative importance, these sub-divisions are not of equal importance in the photo interpretation task. A discussion of the flow of aerial photography to user groups follows in Section 2.2. For the moment, it is sufficient to say that the bulk of photo interpretation is accomplished in the box entitled "Assistant for Photographic Analysis" by an organization called the Photographic Analysis Group (PAG). All other organizations that are part of NPIC provide either service or support for this group.

There are several departmental units residing at NPIC that conduct interpretation from the same sources as PAG and utilize the same services; however, this is done on a non-interfering basis. Two of these units are shown in small boxes on the chart as CIA/NPIC and DIA/NPIC. The former unit, the Image Analysis Division (IAD), is responsible for CIA interpretation requirements and is exceeded in number of photo interpreters only by PAG.

2.2. Photographic Analyses

The flow of photographic data, from acquisition by the sensor to final report generation, is shown in FIG. 2-2. The variety of material handled by the photo interpreter at NPIC is reflected by the assortment of collecting platforms shown in the acquisition phase; this variety ranges from the extremely small scale panoramic photography provided by the KH-4 satellite system to conventional low-altitude DOD photography obtained during Viet Nam operations. All film is developed at sites other than NPIC, and duplicate positive transparencies in roll format are then distributed to NPIC for interpretation.

25X1

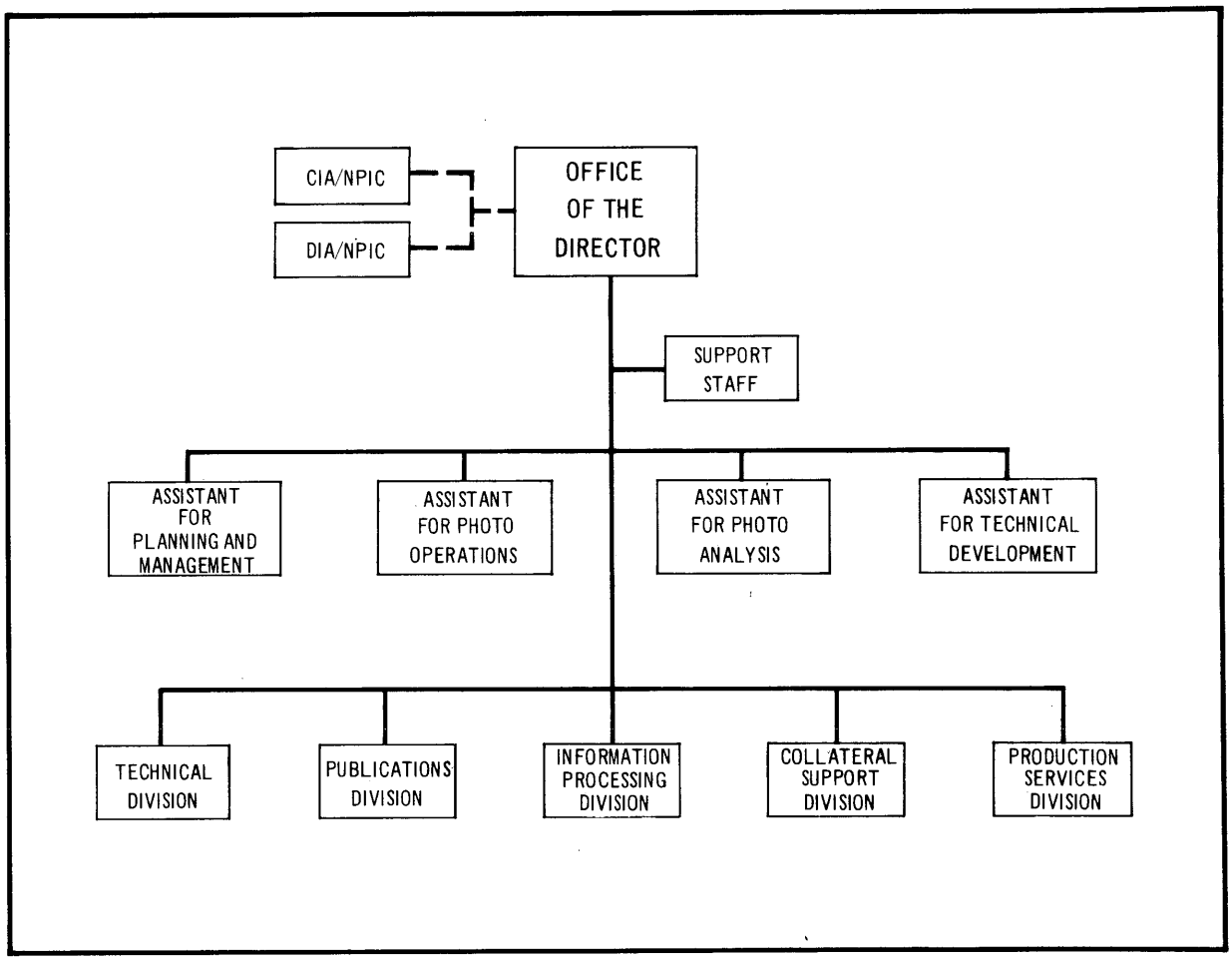


FIG. 2-1. SIMPLIFIED NPIC ORGANIZATIONAL CHART.

25X1

TOP SECRET

25X1

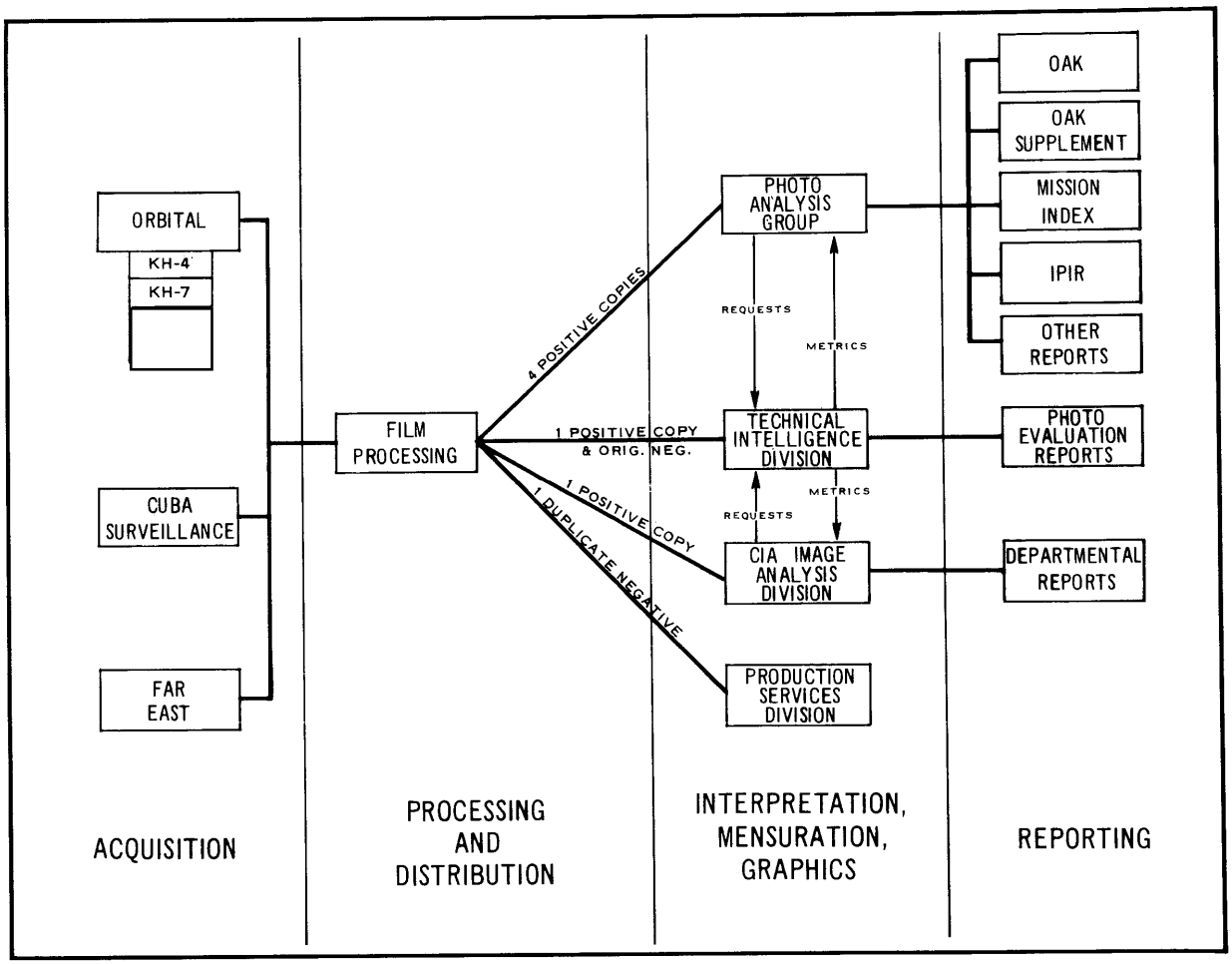


FIG. 2-2. FLOW OF PHOTOGRAPHIC DATA.

The major role of PAG at NPIC is illustrated by the number of positive copies received by them. This distribution arrangement, however, applies only to orbital coverage. The prime role of PAG at NPIC is further emphasized by the variety of interpretation reports resulting from its efforts.

2.3. Reporting

The types of reports produced by NPIC fall into three categories--Phase I, II, III. The OAK and IPIR are examples of Phase I reports, or immediate read-outs. The Phase I report normally is concerned with targets of the highest priority, and the report is produced in a minimum amount of time. Phase II reporting is represented by the OAK Supplement which deals with the lower-priority targets in a longer period of reporting time. Phase III reporting is very detailed and normally in response to a specific request; it is more characteristic of the Image Analysis Division reports than those of PAG.

It should be mentioned that an OAK report refers to the analysis of a satellite mission, whereas an IPIR is the report of an aircraft mission. Other types of special reports are also prepared by the P.I.'s. Reporting is normally in response to some national target priority list, such as the COMOR listing. Report requirements are formatted to a considerable extent which relieves some of the pressure on the interpreter; however, the requirement for searching for new targets is a continual one, and the one which is most difficult to simplify in reporting.

Although reporting is the natural product of intelligence extraction from aerial photography, its automation potential is actually outside of the scope of the ATR program. Reporting will be treated in greater detail in Section 6 to illustrate the effect of report requirements on the interpretation environment.

2.4. Interpreter Support

Little has been said about the service and support organizations within NPIC because these groups are not directly involved in actual photographic interpretation. If there is any exception to this statement, it is represented by TID which is responsible for measurements in support of interpretation. Mention should be made, however, of the Collateral Support Division (CSD) which provides PAG and IAD interpreters with the reference and supplementary information which is so essential to the decision-making process. This is one of the several unique aspects of NPIC

wherein what could be considered supplementary P.I. duties (metrics, researching geographic areas, collecting source materials) have been assigned to support groups in order that the interpreter be allowed full time for the task of examining film images and deducing the significance thereof.

CSD and other service/support groups are discussed further in Section 5.

3. ACQUISITION SYSTEMS.

This section is the first of several which attempt to categorize the photographic information handled at NPIC, and emphasize those items which are of particular interest to the ATR Program. The information plan shown in FIG. 2-2 serves as the model for this categorization.

3.1. General

Acquisition systems are not the responsibility of NPIC, but the materials generated by these systems constitute the reason for an installation such as NPIC, and are the source of what is often considered the most valuable and valid intelligence data available to the U.S. Intelligence Community today. Reconnaissance data is acquired by both satellite and aircraft sensors; the satellite and certain aircraft acquisition system mission characteristics are available at NPIC prior to receipt of photography.

The remainder of Section 3 describes the acquisition systems in terms most pertinent to the ATR Program, and illustrates by photo simulations the appearance of photography obtained by the various orbital systems.

3.2. Orbital Systems

[redacted] 25X1D

All systems discharge their film packages on command; these orbital systems have successfully combined the advantages of high resolution film and long focal length lenses to overcome the reduction of scale and commensurate loss of detail that was previously inherent in high-altitude surveillance missions.

3.2.1. KH-4 System

The KH-4 is a dual panoramic camera system designed to provide wide area coverage from a nominal altitude of

about 110 nautical miles. Since the two cameras are in a convergent mount (fore and aft pointing 15° from vertical), all photography acquired by this system is oblique in perspective. It has been estimated that about 80% of the film exposed by the KH-4 system represents stereo coverage.

Pertinent characteristics of the KH-4 are as follows:

a. focal length - [redacted] 24"

b. film width - 70 mm

c. frame size - $2\frac{1}{4}$" x 30"

d. area coverage/frame - 70° across flight line

e. ground resolution (measured) - about 10 feet

f. film capacity - two 8000' rolls/bucket
two bucket capability

g. negative scale at 110 n.m. (assume vertical photography) - approx. 1:335,000

The simulated examples of KH-4 photography shown in FIGS. 3-1 and 3-2 could represent the central portion of a panoramic frame if the camera axis were oriented vertically. The photographs are 4X reduction from 9" x 9" vertical photography estimated to be about 25 lines/mm in resolution; the high resolution copying techniques provided a 100 lines/mm reduced copy negative. Much of the resolution was probably lost in the contact printing process; however, the prints do serve as an indication of the level of detail obtained from KH-4 photography. FIG. 3-1 simulates a photo obtained at somewhat lower than the 110 n.m. orbital altitude, whereas FIG. 3-2 could have been taken at a higher altitude. Aircraft can be counted and sometimes identified in FIG. 3-1, but the ICBM sites in FIG. 3-2 are less easily detected. The sites can be recognized on the film transparencies at the same scale as the prints, however.

The above examples serve to indicate the detailed type of analysis in terms of sizes and shapes with which

FIGS. 3-1
3-2

FIG. 3-1 Scale 1:240,000 (approx.) Reduced to KH-4 scale. The long-range bombers can still be identified and counted.

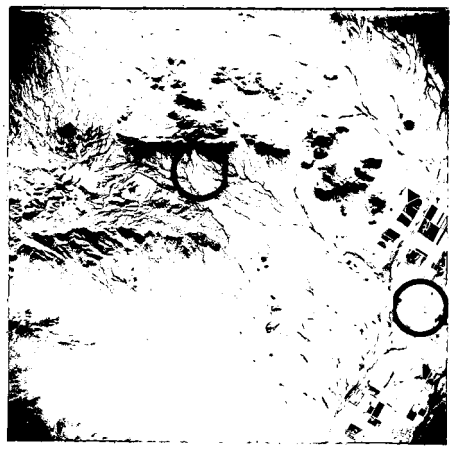


FIG. 3-2 Scale 1:360,000 (approx.) The TITAN silos are more difficult to detect on this print than on the negative; however, KH-4 photography is capable of resolving individual silos in ICBM complexes.

ATR techniques and equipment must cope. The KH-4 photography is the smallest scale material handled at NPIC and probably the medium on which the greatest amount of searching for new targets is concentrated.

3.2.2. KH-7 System

The KH-7 is a single, large format camera which operates in a strip mode and can be aimed by ground command at angles out to 35° from the vertical. This pointing is accomplished through a moveable mirror. Most of the photography obtained by this system is oblique in varying degrees. The average altitude of KH-7 orbit over target areas is estimated at 90 nautical miles. Stereo coverage is obtained by convergent pointing methods.

The general characteristics of the KH-7 are listed below:

a. focal length - 77"

b. film width - 9½"

c. frame size - variable in length, but estimate average to be 9" x 18"

[redacted] 25X1D

e. film capacity - 3000'/bucket

f. negative scale @ 90 n.m. (vertical) - approx. 1:86,000

The photographic simulations of KH-7 material shown on the following pages are slightly larger in scale than material collected at 90 n.m. would be; however, the orbit fluctuates enough to overlap the 1:72,000 range. The simulation procedure was the same as for the KH-4 data. And, again, the illustrated material is vertical whereas the bulk of KH-7 data is oblique. But the point being emphasized, however, is the wealth of targeting information which can be extracted from this photography. The prints, of course, do not hold the quality of the negative but do display enough

FIGS. 3-3
3-4

FIG. 3-3 Scale 1:72,000 (approx.) Naval vessel inventory and rail yard analysis are typical requirements from KH-7 photography.

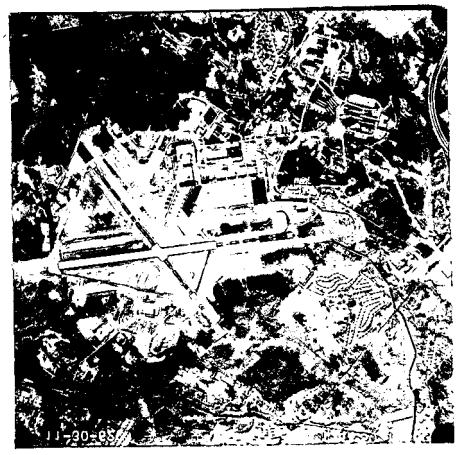


FIG. 3-4 Scale 1:72,000 (approx.) Aircraft identification, particularly of larger planes, is not difficult on KH-7 material when viewed under magnification.

FIGS. 3-5
3-6

FIG. 3-5 Scale 1:72,000 (approx.) This simulated KH-7 photo illustrates the detail which can be extracted from coverage of military bases.

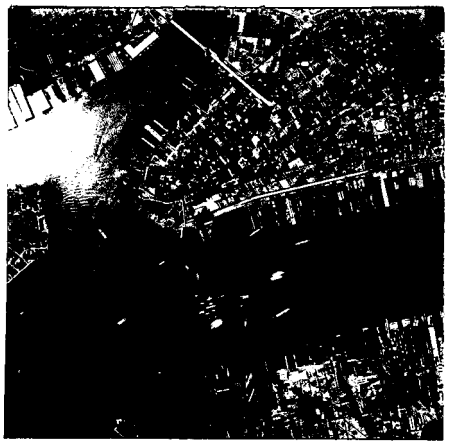
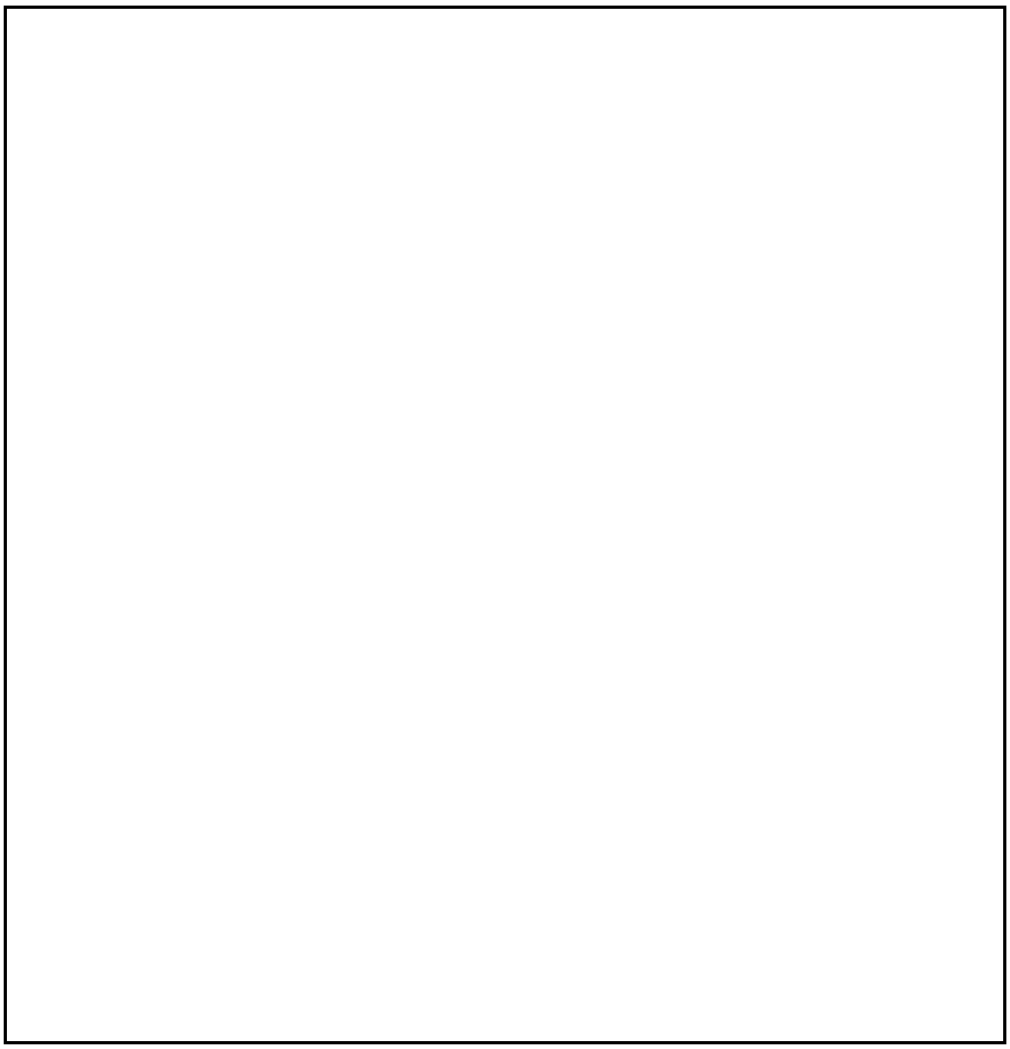


FIG. 3-6 Scale 1:72,000 (approx.) Harbor facilities might look like this on KH-7 material from 90 n.m.

data to indicate the demands made on a P.I. in terms of interpretation requirements. In FIG. 3-3, for example, an inventory of naval vessels would be required, as well as a count of train activity in the rail yard. FIG. 3-4 illustrates the variety of aircraft which can be detected and identified at this scale.

FIG. 3-5 provides detailed coverage of an army camp in which barracks sizes can easily be determined. Identification of the vehicle types in the motor pool might be more difficult, however. The shipping and port activity shown in FIG. 3-6 reflect additional report requirements for the P.I. from KH-7 photography.



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3.4. Far East Surveillance Systems

The most varied, and the least controlled, acquisition systems are those operated in conjunction with reconnaissance and surveillance missions in the Far East, particularly Viet Nam. Altitudes range from "on the deck" to 70,000', film widths vary from 70mm to dual $9\frac{1}{2}$" rolls, frame lengths can be several feet in panoramic systems, and system resolution may run from 20 lines/mm to 60 lines/mm. Reconnaissance aircraft include the U-2, RA-5C, RF-4, RB-66, MOHAWK, and other military types.

One of the most significant aspects about this photographic material is that it often arrives unannounced at NPIC with little supporting data as to exactly where the flight line occurred. The fact is that much of the material has resulted from DOD reconnaissance flights (Air Force, Navy, Marines, Army) and is sent to NPIC "after the fact." However, with the escalation of aerial surveillance in Viet Nam and surrounding areas, the volume of photographic material has increased considerably in past months.

3.5. Future Systems

In the development of ATR techniques and equipment, it is necessary to attempt to determine the characteristics of acquisition systems which may still be in the planning stage. If system resolution will be doubled, if focal length will be increased, if formats different from those under consideration are being considered--then all these items have a decided effect on the direction of the ATR Program. In addition, the exploitation of unconventional sensor imagery will become a growing requirement at NPIC. ELINT material will become a more common input to the P.I. decision-making phase. Also, color film may become of more significance in the future.

The ATR Program has been formulated on the concept that an awareness of new or planned collection programs is necessary for meaningful results to be obtained; thus, close liaison will be maintained with NPIC in this area throughout this effort.

4. PRE-INTERPRETATION FILM HANDLING.

4.1. General

Section 4 discusses what happens to aerial film from the time of exposure to the time of arrival at NPIC. All materials generated by the systems mentioned in the preceding section are processed and duplicated outside NPIC, although NPIC personnel may be at the processing site. The most detailed information available concerns the handling of film exposed by orbital systems, and most of the following discussion will be concentrated on that material.

4.2. Chemical Processing

All black-and-white negative material exposed during orbital passes is developed to a gamma of 2.2 - 2.4, which provides an interesting comparison with the processing of commercial aerial photography (gammas of 0.8 - 1.2). This high gamma development is obviously for the purpose of overcoming the loss of contrast associated with high-altitude photography.

Processing of orbital photography is under direct NPIC observation, whereas other system photography is normally processed by DOD agencies.

4.3. Inspection and Reporting

Again referring to orbital photography, an NPIC team is normally at the processing site to perform a preliminary analysis of each mission. This analysis includes a rapid screening to determine the mission quality, coverage, and cloud cover; a cable is sent to NPIC with this data. This information is used to alert briefing teams and interpreters as to the analysis requirements for each mission.

The cloud analysis conducted on KH-4 material normally includes screening of each successive frame and a determination of percentage of cloud cover on a quarter frame basis. The inspection team may be at the processing site for several days.

4.4. Duplication and Separation

After development of the original negative, the process of printing duplicate positive and negative transparency rolls is initiated. The long rolls must be broken into useable film

increments for interpretation. The fact that the original negative is a thinner base material than the duplication material is another reason for sub-dividing the rolls. A KH-4 roll may be split into 250 sections, or cans, whereas a KH-7 roll, being considerably shorter, may provide only 50 cans.

When we consider that six positive copies are sent to NPIC, this indicates that a KH-4 roll could provide 6 x 250, or 1500, cans of film to NPIC.

It has been estimated that the loss of resolution in the duplication process does not exceed 10%.

4.5. Distribution

The delivery of copies of the orbital missions normally occurs within 72 hours from receipt of the material at the processing site. The Cuban material may be a little slower in delivery, and the Far East material may be several weeks in arriving at NPIC.

Six duplicate positive and one duplicate negative of orbital coverage represents the normal flow to NPIC from the processing site. The original negative eventually arrives at NPIC after being used by DOD agencies for further reproduction.

5. THE NPIC STRUCTURE.

5.1. General

Photo interpretation is the primary business of NPIC, and the organizational structure has been developed to assist interpretation in terms of speed and accuracy, and to provide whatever support that is necessary for this purpose. As mentioned in Section 2, and shown in FIG. 2-1, the actual NPIC interpretation activity is represented by the block entitled "Assistant for Photographic Analysis" under which the Photographic Analysis Group (PAG) operates. There is another sizeable interpretation group, CIA's Image Analysis Division (IAD), which is responsible only for CIA requirements.

All other NPIC divisions provide service or support to PAG, and, in a secondary way, to CIA/IAD (CIA/NPIC).

5.2. Interpretation Organization

National interpretation requirements are the responsibility of PAG; departmental requirements are handled by interpretation groups who are employees of the sponsoring department. Thus, CIA, Army, Air Force, Navy, etc., have groups which utilize NPIC source data; however, these departmental groups may not be physically located at NPIC.

5.2.1. Photographic Analysis Group (PAG)

PAG employs about 150 photo interpeters, which are roughly 50% DIA personnel and the remainder CIA employees. Personnel from CIA's Image Analysis Division are periodically rotated in PAG; however, DIA personnel do not work in CIA/IAD.

PAG is responsible for satisfying national requirements in photographic analysis in response to various target listings and report requirements. Targeting priorities and the makeup of OAK and IPIR reports are described in Section 6. An indication of the targeting interests of PAG can be deduced from the following organizational listing:

PHOTOGRAPHIC ANALYSIS GROUP

Geographic-Military Division	Scientific and Technical Division
•Military Branch	•Nuclear Energy Branch
•Geographic Branch	•Defensive Missiles Branch
•Industrial Branch	•Offensive Missiles Branch

5.2.2. Image Analysis Division (IAD)

IAD is responsible only to CIA for target areas of interest and report requirements. However, the division does provide interpreters to PAG on a rotation basis. These PI's comprise about one-half the photo interpreter personnel within PAG. Thus, IAD is involved primarily in detailed reporting in response to specific or standing requests from CIA and in providing experienced PI personnel to help fulfill NPIC requirements.

The organization within CIA/IAD is not quite as detailed as in PAG, but does cover the same targeting categories:

CIA/IMAGE ANALYSIS DIVISION

- Operations Support Branch
- Missiles - Electronics Branch
- Atomic - Biological - Chemical Branch
- Geographic - Military Branch
- Industrial Branch

5.2.3. Other Departmental Units

Both DIA and Army have small interpretation groups at NPIC; other government agencies have groups formed for the same purpose but not located at NPIC. The purpose, of course, is to utilize the unique photographic material available at NPIC. However, since these departmental units do not influence the NPIC operation in any significant manner, they will not be discussed further.

5.3. Support Organizations

All divisions of NPIC, other than that in which PAG operates, provide service and support for the photo interpretation task. This support includes measurements, reference material, computer processing, printing, and photographic reproduction. Copies of orbital film are received by the Technical Intelligence Division (TID), where it is used for mensuration purposes, and by the Production Services Division (PSD), where photographic reproductions are prepared.

5.3.1. Technical Intelligence Division (TID)

TID is responsible for all mensuration data emanating from NPIC; in this regard, it operates a number of sophisticated measuring devices from which the output is normally computer processed. The [redacted] Comparator is probably the basic mensuration tool in TID. With this device, target locations are recorded on punched cards which are processed off-line in a computer system to provide distances and sizes in appropriate ground increments. An on-line measuring system is the [redacted] dual screen viewer, which prints out measurements following operator positioning of a cross-hair. Other equipment includes X-Y plotters and stereo plotters; however, very few 3-dimensional measurements are taken at NPIC.

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Another branch within TID is responsible for the preparation of the Photo Evaluation Report, a critique of mission quality in terms of resolution, coverage, deficiencies, etc. This report is derived from examination of the original negative which is received at NPIC several weeks after initial processing. A Photo Evaluation Team is convened after all mission deficiencies are determined in an attempt to rectify or determine causes. The Photo Evaluation Report is heavily slanted toward interpretability and tends to be rather negative in its assessment of mission performance.

5.3.2. Collateral Support Division (CSD)

CSD is responsible for researching, collecting, analyzing, and preparing the basic reference material used by photo interpreters at NPIC. From its vast collection of books, reports, documents, ground photography, maps, etc., CSD is able to provide targeting data for all areas of NPIC interest. CSD's important role can best be illustrated by a description of their efforts in connection with the processing of orbital photography. CSD translates the telemetry data to useable information for the P.I.'s in terms of site, coordinates, frame number, and location within the frame. They prepare target briefs for each installation covered which includes small-scale transparencies for orientation, maps, and computer-generated summaries of past P.I. Reports, report requirements, and prior mission references. CSD personnel brief interpreters on the general characteristics of each mission received at NPIC.

Most textual material is maintained in the MINICARD system where it can be rapidly retrieved when needed. The same information is also being prepared on 16mm and 70mm roll film for use on conventional viewers. Location of aerial coverage can be determined by reference to WAC indexes on which reductions of coverage have been superposed at map scale. This system provides a very useable solution to the problem of location and cloud cover amount for each orbital mission.

5.3.3. Information Processing Division (IPD)

IPD provides the computer support required by the interpreters at NPIC and operates the MINICARD system

for CSD. Computer support involves measurements, telemetry reduction, and report preparation. For measurements, the geometry of each frame is calculated for orbital photography; the punched cards provided by TID are processed against the frame geometry to correct for the obliquity of each photo.

The heaviest load falling on IPD relates to report preparation and distribution. For reports such as the OAK, P.I. notes are keypunched, one line to a card, and the final report is produced on line printers. As a result, a heavy input/output requirement is placed on the UNIVAC system although the central processor has considerable free operating time available.

5.3.4. Other Support Units

The remaining divisions of NPIC, such as the Publications Division and the Production Services Division, are concerned primarily with the report function and serve to provide the graphics, reproduction, and editing capability required. These groups become involved with film handling in the control of incoming film, and through the enlargements and contact prints made from duplicate negative frames. Although essential to the operation of NPIC, these groups have no influence on interpretation procedures.

6. PHOTOGRAPHIC ANALYSES AND REPORTING.

6.1. General

Photo interpreters seldom are given film to analyze without some pre-mission knowledge; there are usually certain "ground rules" established reflecting target priorities, time constraints, and the like. This situation is particularly true at NPIC where, because so much of the coverage is repetitive, more formalism in analysis and reporting has been created. Also, at NPIC, there exists a body of career photo interpreters; this category of interpreter is practically non-existent in DOD service interpretation groups. The fact that NPIC P.I.'s do display longevity makes it possible for a wealth of experience to be brought to bear on the photo analysis workload of NPIC. The ability to recognize distinctive shapes, patterns, and changes results mainly from experience; the interpreter at NPIC, therefore, represents what can be considered the optimum human target recognition device.

The remainder of Section 6 will describe how photo interpretation is conducted at NPIC in order to provide comparative data for the ATR Program. The operation of PAG will be used as the basis of this material and reference will be made to IAD when pertinent. Most of the procedures refer to the methods by which satellite photography is handled at NPIC; however, other material is handled in a similar fashion.

6.2. Analysis Requirements

The photo interpreter at NPIC looks primarily for targets whose priority has been established, and he reports on these targets in order of descending priorities. He has available to him past target analyses and knows what observations are required of him. Furthermore, the requirements must be fulfilled within a specified time period.

6.2.1. Target Priorities

The largest categories of interest to NPIC interpreters are reflected, in a general way, by the structure of PAG given in Section 5.2.1. Those targets of highest priority have been so designated by the Committee on Overhead Reconnaissance, and are called COMOR targets. There are about 4500 active COMOR targets and 500-600 inactive. In addition, NPIC has its own target list totalling about 15,000 non-COMOR targets.

The highest priority COMOR target categories are those which are considered to represent the greatest threat to the United States. The following list of COMOR targets illustrates this fact.

COMOR Target Categories

1. Guided Missiles

   A. ICBM Deployment
   B. IRBM and MRBM (including search areas)
   C. Research and Development (including space)
   D. Production Facilities (including test)
   E. Suspect Missile (Search area of undetermined activity)
   F. -----
   G. Naval Launched Missiles
   H. Anti-Missile Missile
   I. SAM Sites

J. Short Range Surface-to-surface Missiles
K. Missile support/storage areas
L. SAM Training Complexes

2. Aircraft

A. Long Range Bases
B. Production Facilities (including R and D)
C. Airfields

3. Nuclear Energy

A. Test Area
B. Production
C. Stockpiles
D. Research Institutes
E. Suspect Activity

4. Naval Activity

A. Operating Bases
B. Production Yards
C. Commercial Ports
D. Locks and Canals

5. Biological/Chemical Warfare

A. BW/CW Test Areas (including test)
B. Production
C. Storage
D. Research Institutes
E. Suspect Activity

6. Electronics

A. Missile Tracking Facilities
B. Electronics (general)

7. Military

A. Military Installations
B. Special Area
C. -----
D. Landing Beaches

8. Urban/Industrial

A. Complexes
B. Industrial Plants
C. Geodetic Control Points

9. Other

A. U/I Unidentified Installations

[redacted]

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11. Mapping and Charting (In countries not targeted by COMOR)

A. Urban Complexes
B. -----
C. Airfields
D. Ports

The Cuban coverage has its continuing priority areas which are read out shortly after receipt of the film. The Far East coverage requires both pre-strike and post-strike analysis, including bomb damage assessment. There is considerable effort expended on this material on searches for SAM sites, potential bridges, and oil storage areas.

6.2.2. Readout Criteria

Since the primary function of orbital missions is to provide surveillance, the major occupation of PAG interpreters is the analysis of change. As mentioned previously, much of the orbital data is repetitive, and has been for several years. To many interpreters who have specialized on certain targets over this period of time, the new coverage is truly like "looking in their own backyard." Therefore, changes can often be noted almost instantly.

It follows, then, that a readout of highest priority targets in terms of significant change becomes the first order of business. This requirement may be quite time-consuming if the target is complex. For example, one ICBM installation is known to have about 90 silos. To determine if any new silos have been constructed, it is necessary to first count all the silos in the target complex. Another example is the heavy bomber base. Here, a count of the number and type of aircraft is required to establish whether any significant shift in aircraft has occurred.

Following readout of priority targets, a search for new or bonus targets may be conducted. There are also standing requirements, such as searching the terminus area of all rail spurs for evidence of new construction. There is also the large amount of NPIC targets which must be reported on when covered.

The target brief furnished by CSD normally designates what comments are to be made by the P.I. for each target.

This brief contains summaries of P.I. reports on prior missions which are very helpful in change assessment. And finally, but perhaps most important, each P.I. team has its own "chip file" which contains the actual photographs from previous missions for each target.

6.2.3. Time Constraints

It has been found at NPIC that the average P.I.'s efficiency starts dropping after 6-8 hours and this has been a determining factor in the time-scheduling for mission analyses. The readout of an orbital mission that begins at 0700 will be terminated at 1400 - 1430; if the readout has not been completed, it will be continued for the same time period the following day. For each day's interpretation, a report will be issued the following morning.

The Cuban coverage is so well known now that the complete readout is normally finished within one day. The schedule for the DOD-acquired coverage in the Far East is somewhat different. NPIC is allowed five days to conduct their analyses of this material.

It appears to be a reasonable assumption that the amount of photo analysis completed will not necessarily

increase with increased interpretation time. And it is doubtful whether interpreter speed can be increased without affecting accuracy. A rising workload has been predicted for NPIC and, without machine aids, either analysis requirements or time constraints will have to be modified.

6.3. Operational Interpretation

In the OAK and IPIR operation, PAG interpreters are normally divided into teams by area or subject specialities. A CSD representative is assigned to each team to provide additional reference material as needed. The interpreters work 7-8 hours a day until the mission analysis is completed. After the P.I. reviews and verifies his notes, the IPD prepares the reports. PAG personnel have standing requirements which occupy the P.I.'s between mission readouts.

6.3.1. Film Handling

The appropriate cans of film have usually been allotted to the team stations by the time the interpreters arrive for work. If the film had arrived the previous evening, supervisory personnel may have checked and selected certain frames for use on briefing boards. As shown in FIG. 2-2, four copies of the orbital photography are received by PAG (one is used as a work copy), one copy by TID, one copy by IAD, and a duplicate negative by PSD. Since the service groups have copies of the same photography being used by the interpreters, it is not necessary to send film out for measurements or reproductions. The X-Y locations of the image area can be furnished instead of the film, or the P.I. can point directly to the areas of interest.

After mission analysis is completed, all film is returned to PSD for storage or disposition. DOD photography is returned to the furnishing agency. Once film has left NPIC, it is a rather slow process to regain it.

6.3.2. Interpretation Requirements

To illustrate how information is extracted from photography, an OAK operation will be described. An OAK is the readout of COMOR targets from orbital photography. One interpreter team that will work on the OAK is that group responsible for Naval Order of Battle (NOB) information. This unit is within the Geographic Military Division of PAG and can consist of five P.I.'s plus a CSD support man. As

mentioned previously, one of the first items of business is the selection of material for briefing board preparation. This is normally in response to a direct or standing request from higher levels.

There are probably several cans of film which represent those areas most likely to contain NOB information. This can often be a problem in that the world does not separate neatly into target categories. It is quite likely that Navy and Industrial targets occur in the same frame. In this case, close cooperation among working teams is necessary.

Assuming that the cans of film do contain the bulk of the NOB data, the analysis will be concentrated on port, coastal, and water coverage. The photography is attacked by priorities; 1A and 1B COMORS are reported in the OAK, 1C COMORS in the OAK SUPPLEMENT, and 1D targets represent a search of all water areas. P.I. notes are prepared as requested in the Target Brief, edited, and keypunched. This process may be slowed somewhat when the necessity for measurements arises. All published measurements in NPIC reports must have been generated by TID. Therefore, a plot of the objects or features for which dimensions are needed is furnished to TID, and often TID and PAG personnel work together until all points have been measured on the comparators. The punched cards then go to IPD where the ground distances are computed.

The bulk of roll film analysis is accomplished on a light table through a binocular microscope. Most stereo viewing is accomplished through the use of chips - $2\frac{1}{2}$" x 5" (average) film transparencies, which have been cut from the positive rolls. For stereo viewing, the [redacted] Twin Dynazoom is the usual viewing instrument used. Questions have arisen about the utility of stereo viewing since very few height measurements are taken. A strong reason for the stereo viewing capability is that the 3-dimensional model overcomes, to a large extent, the lack of contrast which makes object identification difficult. By the same token, stereo offers increased definition of edges for measurement purposes.

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PAG interpreters rely on their film chip files for the bulk of the change analysis requirements. The material is at their fingertips and in an approximately common format. However, the one work copy from which chips are cut may be inadequate in terms of target separation; it is often necessary to cut at odd angles to avoid damaging an adjacent target area.

Order of Battle information - the count and identification by types of naval vessels, aircraft, and military vehicles - is one of the more time-consuming tasks assigned to NPIC interpreters. Many identifications are dependent on a measurement readout, and the requirement for measurements may further slow task accomplishment.

Normally, an OAK operation requires about 100 P.I.'s; the remainder of PAG's interpreters are held free for other work. Typical of the growing workload at PAG is the amount of Viet Nam coverage arriving at NPIC. This material is analyzed by both PAG and IAD interpreters. In the five day span allotted for completion of mission analysis, the following information is determined:

a. changes in SAM deployment
b. bomb damage, primarily transportation lines
c. road and rail construction, surfaces, widths, equipment
d. bridges - types and sizes, new locations
e. ports - quays, piers, handling facilities, sizes
f. POL analysis - capacities, dispersal areas, etc.

This list is only partial, and the depth of detailed analysis expands to meet the time available.

6.4. Reporting

The bulk of P.I. reporting at NPIC is reflected by the number of reports which are generated there. In addition to the published reports, cables are sent to selected groups when image information is extremely significant. However, the major contribution of PAG to the intelligence community is the OAK, a readout of COMOR targets from orbital missions, and the IPIR (Immediate Photo Interpretation Report), a similar report from aircraft missions. There are a multitude of lesser reports for specific purposes.

6.4.1. OAK Reports

The OAK is actually a series of reports on the satellite missions. COMOR targets are read out in daily increments (Part 1, Part 2, etc.) until completed. The OAK Supplement picks up the lower priority targets and represents a complete frame-by-frame analysis of the photograph. The Mission Index, required on KH-4 data, is a summary of target coverage obtained from the mission.

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As an example of the work involved in the preparation of OAK material, the following data was tabulated from Mission 4030 (KH-7):

OAK Segments	COMORS READOUT	NON-COMORS & BONUS REPORTED
Part 1 - OAK	117	
Part 2 - OAK	192	
Part 1 - OAK Suppl.	120	
Part 2 - OAK Suppl.	143	
Part 3 - OAK Suppl.	107	34
Part 4 - OAK Suppl.	121	14
Part 5 - OAK Suppl.	84	24
GRAND TOTALS	884	72

6.4.2. Other Report Types

A variety of reports are generated by NPIC, some of which are mentioned below. The IPIR has been mentioned earlier as being the equivalent of satellite photography for aircraft photography. In addition, there are the following:

a. Summary Reports
b. Detailed PIR (Photo Interpretation Report)
c. Brief PIR
d. P.I. Note
e. Photo Evaluation Report
f. Frame Ephemeris Technical Report
g. Mission Coverage Plot Technical Report
h. P.I.L. (Photo Intelligence Listing)

7. NPIC AND THE AUTOMATIC TARGET RECOGNITION PROGRAM.

7.1. Background

To place the ATR Program in its proper perspective with the NPIC operation, it would be well to review certain areas for which ATR techniques and equipment were requested or proposed at the initiation of this program. These were as follows:

a. Screening
b. Coarse classification
c. Change detection
d. Counting
e. Re-scanning, or File Searching
f. Interpreter support
g. Mission indexing
h. Map matching

No priority was established on the need for each of these categories; on the other hand, a list was formulated which placed each category in a position commensurate with its ease of implementation. Screening, for example, appeared to be the most amenable to solution; interpreter support in the form of target identification is a more difficult requirement.

25X1A [redacted] had its own definition for each of these categories, and one of the first tasks was to ascertain what was actually occurring at NPIC that had generated this list. This, then, is a simple explanation of the reason for Task No. 6. Other data, such as processing time, accuracy, amount of operator control, and output formats, was also needed to establish guidelines for the ATR effort. And, lastly, it was necessary to determine the targets (and signatures) of NPIC interest.

It is not too surprising that changes in the ATR Program objectives have resulted from the investigation conducted under Task No. 6. This was, after all, the major reason for the study. The effect of these changes on the initially recommended areas of effort was discussed in the remainder of this section.

7.2. Screening

This category of ATR development which was considered the least complex to develop has been found to be low in priority of need at NPIC. There is little 2-class sorting done by interpreters at NPIC. Satellite photography and the Cuban coverage are largely repetitive, and require little time for the interpreter to find the target areas of interest. The KH-7 [redacted] systems are pointed at selected targets, thereby 25X1D obviating any need for searching. The KH-4 covers a much greater area but, again, analysis is concentrated on known areas of interest.

There is a possibility that a screening system could be introduced at the processing site for, at least, a frame cloud

analysis. This is currently accomplished by TID personnel but could be done by machine techniques. In addition, a culture - no culture frame annotation (with X-Y coordinates) could be furnished the P.I. to direct a more detailed analysis of machine - indicated image areas. This sort of screening system would become more valuable if coverage is obtained over geographic areas for which less information is available.

When and if a screening system is developed, consideration should be given to integrating it with the film processing system at the processing site. Screening can be accomplished at a speed which will not affect film processing times and which will precede the interpretation phase. It is probable that, with the development of a screening system, more searching will be done than time allows at present.

7.3. Coarse Classification

There appears to be no pressing need for this capability at NPIC; the targets, in general, are well known and emphasis is placed on either component analysis within the target, or change determination. However, a classification technique would be valuable on new coverage of areas that were not familiar to the interpreter. Such a categorization could provide the interpreter with cues or general guidance as to gross target types.

7.4. Change Detection

Change detection, or the analysis of change, is the major requirement placed on NPIC interpreters. It is not a simple task to define because, associated with change, is significance. In other words, not all changes within a target complex will be reported; the changes must be significant to the interpreters.

A first step to providing ATR aids to interpreters would be to develop change detection techniques that are insensitive to seasonal changes (leaves, snow, water, etc.) or sun angle changes, but are sensitive to cultural changes. Following this, a method of enhancing or denoting the object or features in which change has been detailed could be very useful. A listing furnished to the P.I. giving frames and X-Y's for all change locations could reduce interpretation time significantly.

7.5. Counting

A majority of individuals contacted in PAG and IAD indicated that counting, particularly by type, is one of the more

time-consuming tasks encountered by interpreters. This problem is best illustrated by consideration of the number and types of aircraft at air bases, vehicles at military bases and motor pools, and ships at naval bases. Other examples include silos in a missile complex, commercial shipping in a port or harbor area, POL tanks in a storage or refinery area, trains or cars in a rail yard, or bunkers in an ammunition depot. The problem is not finding the target but determining what constitutes the target.

Counting by itself is a problem area if one considers the embarrassing situation where one is unable to recall whether an item has previously been checked off. A display which automatically indicates which items have been counted would be desirable. The problem becomes much more complex when counting by type is required. This becomes, first, a problem of identification which is more than just a counting function. After identification, by type, the counting requirement becomes paramount.

Object identification and inventory comes under the heading of Order of Battle reporting and carries a relatively high priority in image interpretation at NPIC.

7.6. Re-Scanning or File Searching

PAG does very little rescanning of the photo file, primarily for lack of time. IAD is probably more involved in this area because of their function in responding to specific requests. This category of ATR has been emphasized in the past because it is the type of operation which is ideally suited to machine operation. It can be done off-line without interfering with the normal P.I. operation at NPIC. This assumes, of course, that the required ATR techniques can be developed.

A rescan capability would be valuable in the rail spur search, cueing the interpreter to specific locations for detailed study. The continued SAM site search is another applicable area. Bridge inventories, such as that required on Viet Nam coverage, could also be done by machine.

7.7. Interpreter Support

ATR techniques developed to assist interpreters should be primarily in the cueing and counting areas. The image enhancement capability is a case in point. Enhancement is a normal

by-product of electronic ATR techniques and could be used to good advantage in any ATR system. Enhancement, in this instance, is used merely to direct an interpreter to an image area requiring further study. Emphasis on areas of change is a good example of how enhancement could be used.

Another ATR aid to interpreters would be some sort of display system to assist interpreters in counting or inventorying. One concept envisions a possible light gun approach wherein the interpreter touches each object on a display and the object either is emphasized, colored, rejected, or outlined. At the same time, a counter would be recording each decision.

Other interpreter support procedures could involve ATR techniques with storage and retrieval developments, man-machine consoles, and sophisticated viewing devices. It is too soon to estimate the effect of the ATR Program on other studies or developments at NPIC.

7.8. Mission Indexing

This report requirement is mentioned because, at the time of procurement, mission indexing was a very detailed, exhaustive task requiring many interpreter hours within PAG. Now, however, M.I. is confined to the KH-4 system only, and is not of the priority that it formerly was. In fact, the entire reporting problem is included in another NPIC study and is outside the scope of the ATR Program from a solution viewpoint. However, any ATR systems eventually adopted will have considerable effect on reporting procedures so there must be some cooperation between the two programs.

7.9. Map-Matching

The general problem of orienting a photograph to a map reference, a normal task with military interpreters, is non-existent with much of the NPIC material. Orbits are known and coverage areas are plotted prior to interpretation. The geographic areas are so well known to many of the interpreters that there is hardly any need to refer to a map.

The situation is somewhat different for certain of the Far East photography received at NPIC. In this case, NPIC has no knowledge of the planned flight line or, at most, has a rough indication of where the flight line was. Here there is a map-matching problem which is worthy of study in the ATR Program.

An argument may be advanced that the need applies to an area in which there may be little interest by the time a map-match capability becomes available. However, there is a strong feeling that there will always be some area of international tension.

8. SUMMARY.

During the course of the initial Task No. 6 investigation, it became obvious that certain conditions exist at NPIC that exert important influences on equipment development. Several of these are listed below:

* NPIC is very much interpreter-oriented. Equipment rejected by the interpreter is, for all practical considerations, rejected by NPIC.

* No ATR equipment is acceptable which slows down the present reporting process.

* ATR techniques must be developed to operate primarily on oblique photography.

* Electronic displays of satellite photography appear to be unacceptable because of resolution loss.